



Extreme sea levels and the assessment of future coastal flood risk

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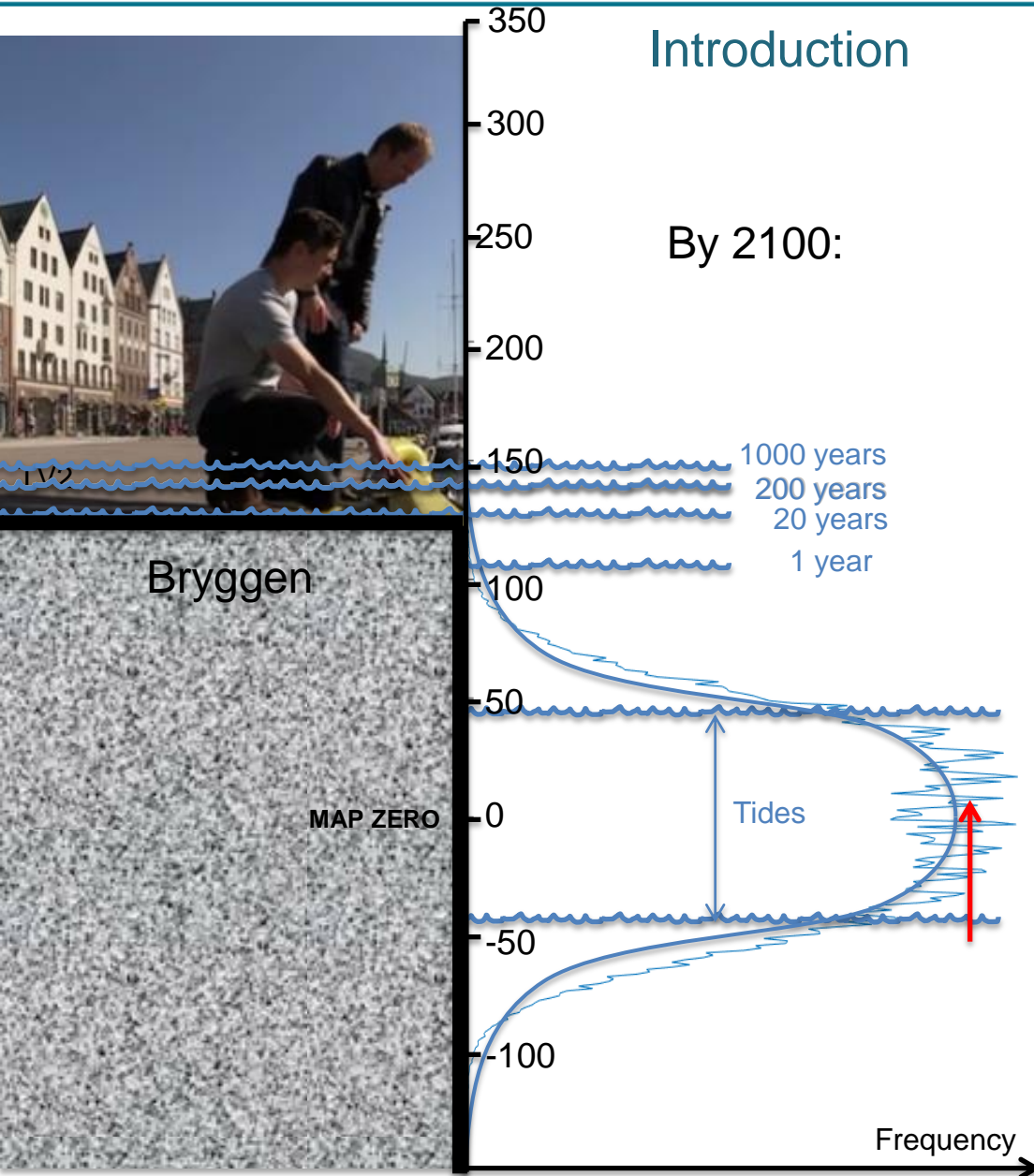
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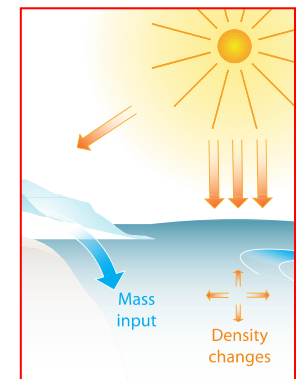
Introduction

By 2100:

Higher return heights
Flooding more often



50 cm sea level rise



kartverket.no/sehavniva ; www.kyst.dk

- › Differences for the coastlines of Norway, Denmark, Sweden, and Germany
 - impacts and vulnerability
 - tide levels, storm surges, future sea level change
 - methodologies for climate change projections
 - methodologies for extreme events
 - approaches for dealing with coastal flood risks and climate change
 - governance adaptation schemes
- › Need for enhanced trans-national collaboration
 - Provide more robust measures for mitigation and adaptation
 - Wider dissemination across levels of governance and between the northern European countries
- › A starting point

Bryggen



Färjestaden



Skanör



Different impacts

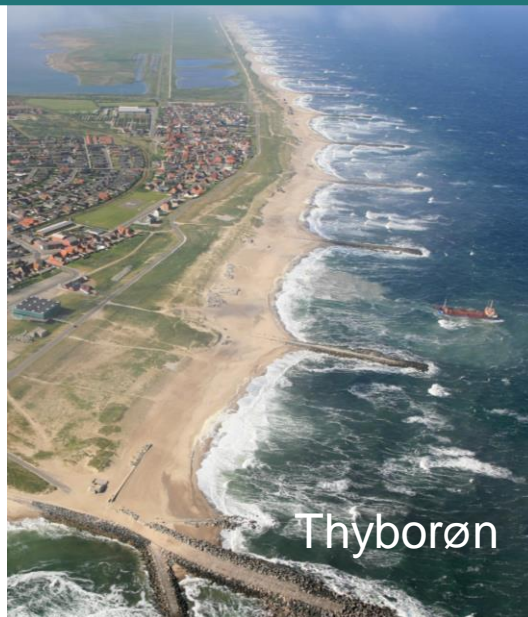
Kabelvåg



Stavanger

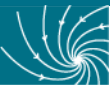


Thyborøn



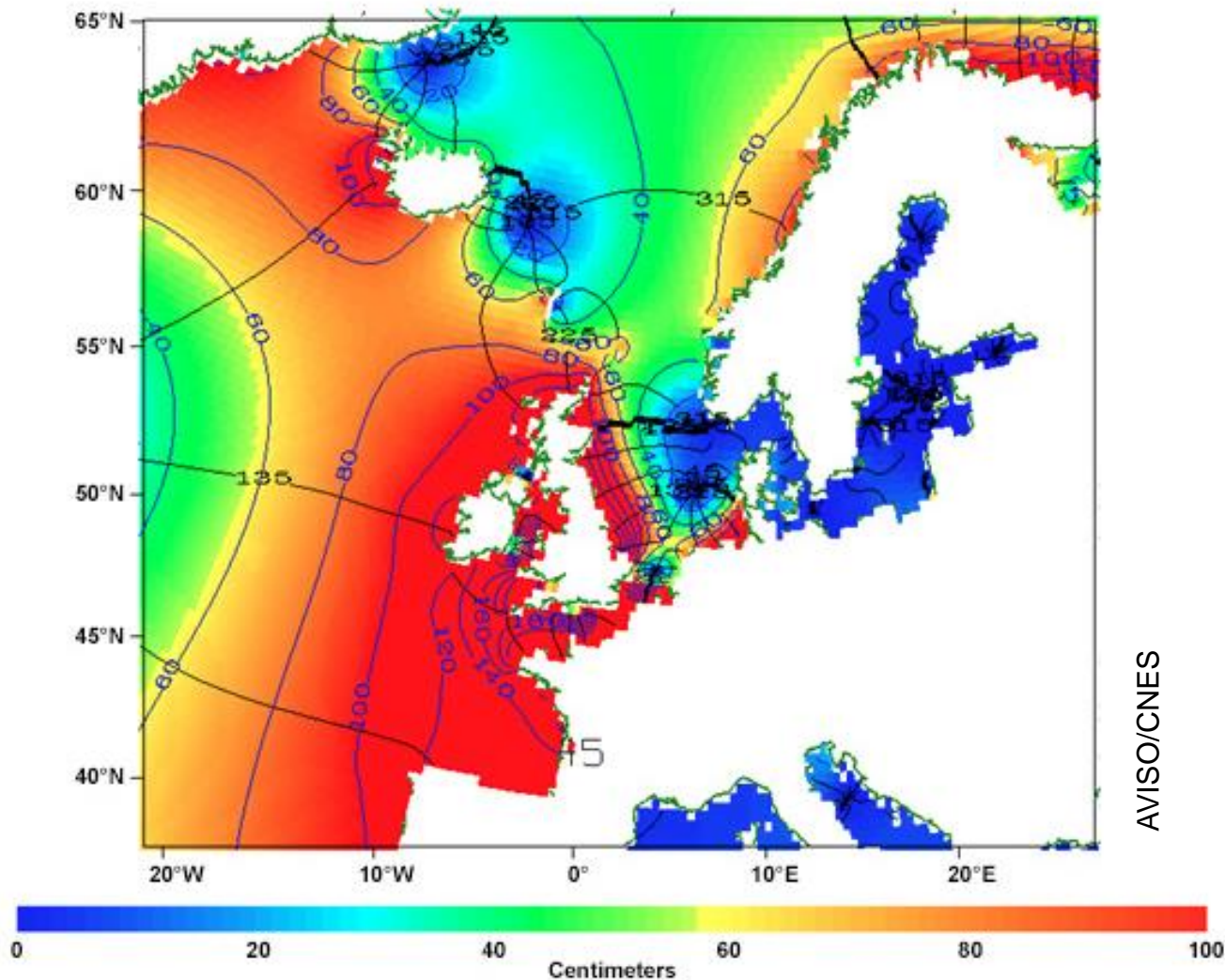
Hamburg



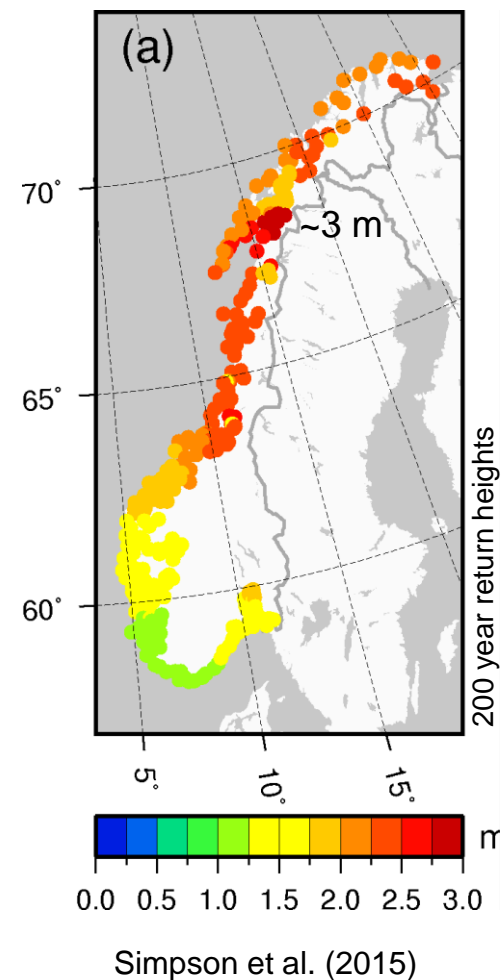
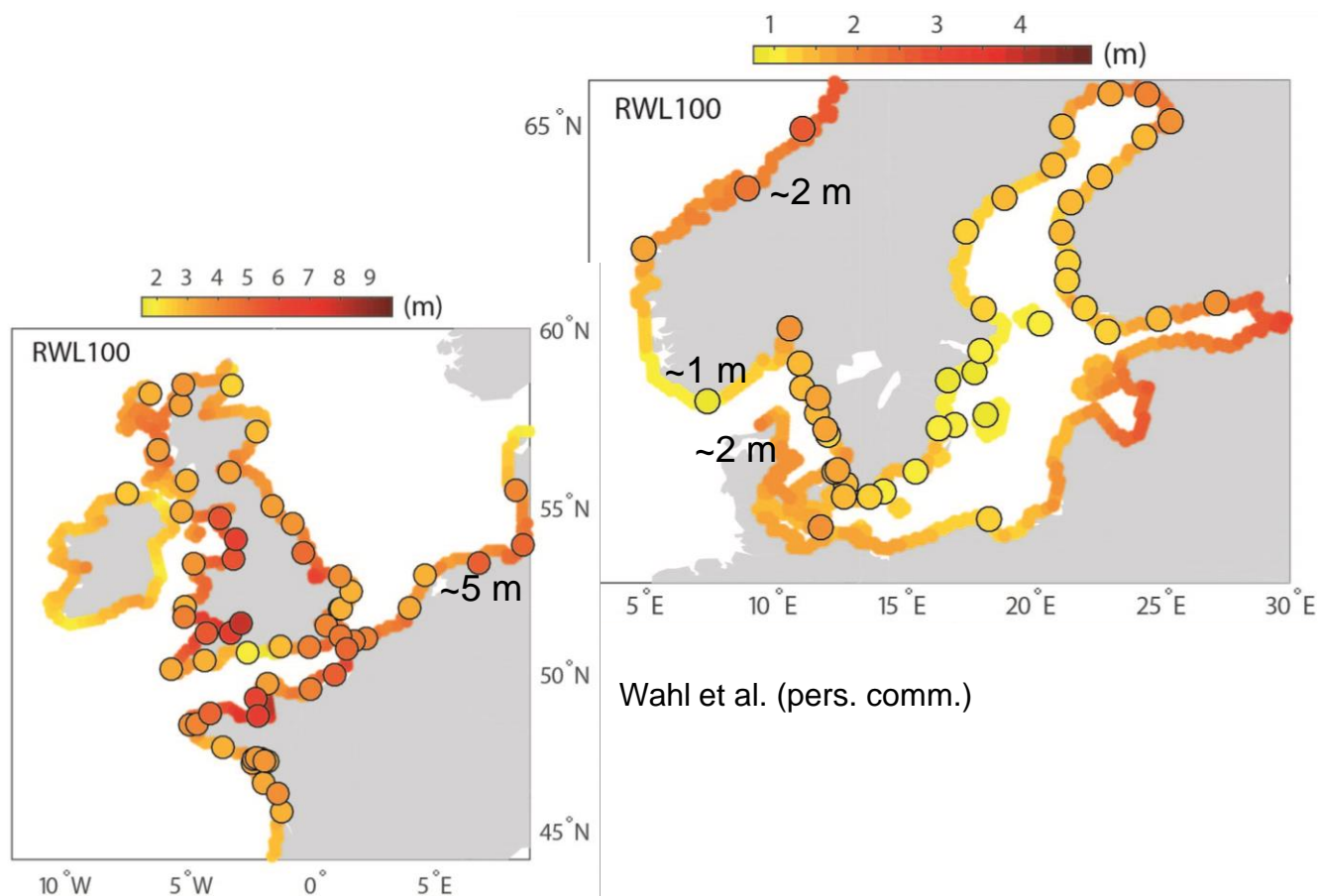


Physical differences: Tidal ranges

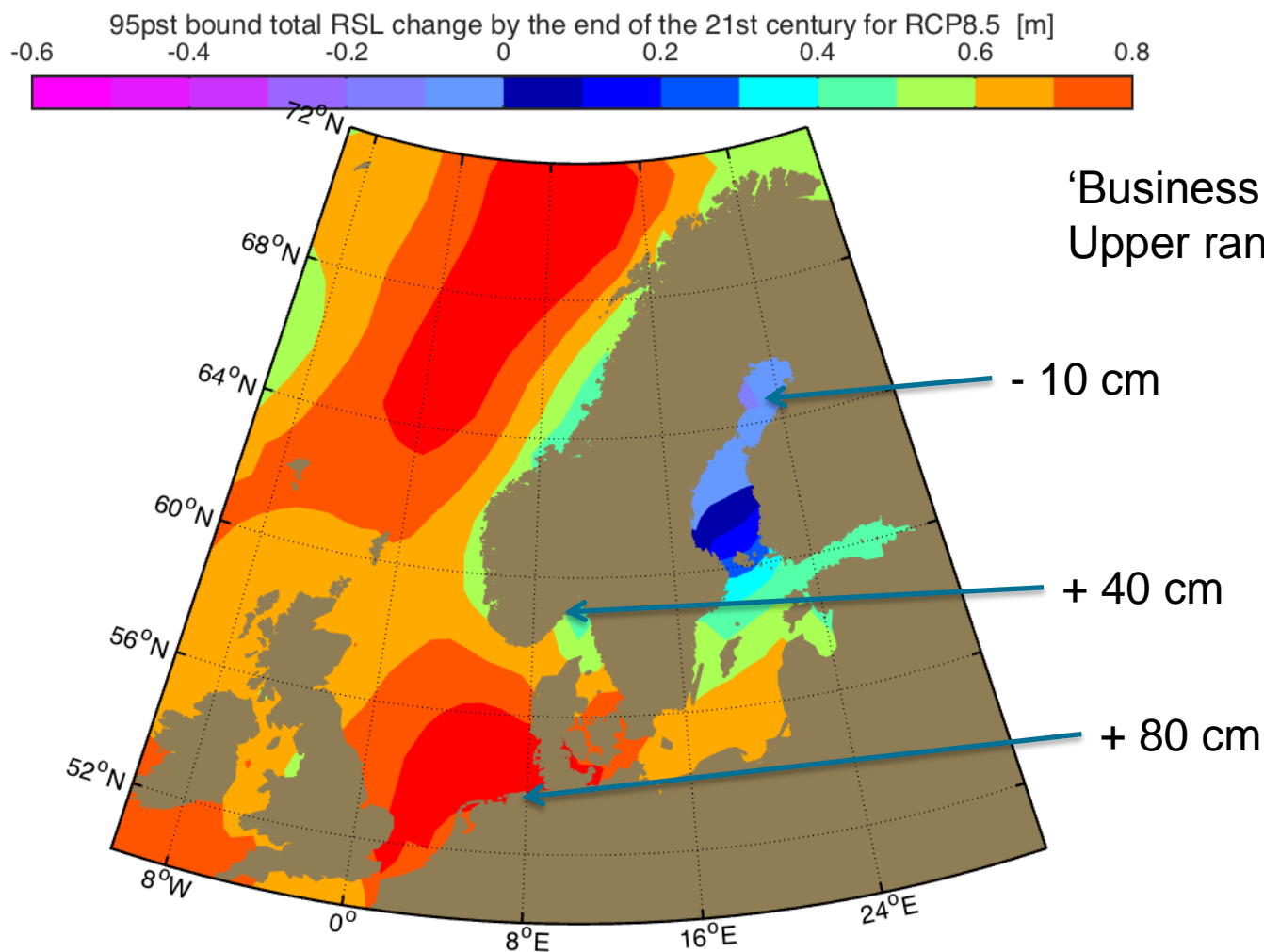
Northeast Atlantic M2 Tidal Amplitude (cm) from FES2012 Model



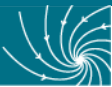
Return water levels (RWL)



Physical differences: Projected Sea Level Changes



Ref: IPCC AR5 Chapter 13. Data: http://icdc.zmaw.de/ar5_slr.html



Climate change reports: National, ... , and IPCC AR5



- Different foci
- Different expertise
- Different methods used
- Different parameters presented
- Nothing official on common Nordic/North European scale?



Methodological differences: Extreme Value Analyses

Norway:

- 22 tide gauges
- 25–102 year series
- detrended
- ACER-method
- 20, 200, 1000 years RWL
- Tidal analysis in 300 zones
- Weather effect from nearest tide gauge used



Roalddotter & Sande (2016)

Denmark:

- 68 tide gauges
- 15–125 year series
- detrended
- POT-method (mostly)
- 20, 50, 100 years RWL
- Interpolation between tide gauge stations



Sørensen et al. (2012)

Sweden:

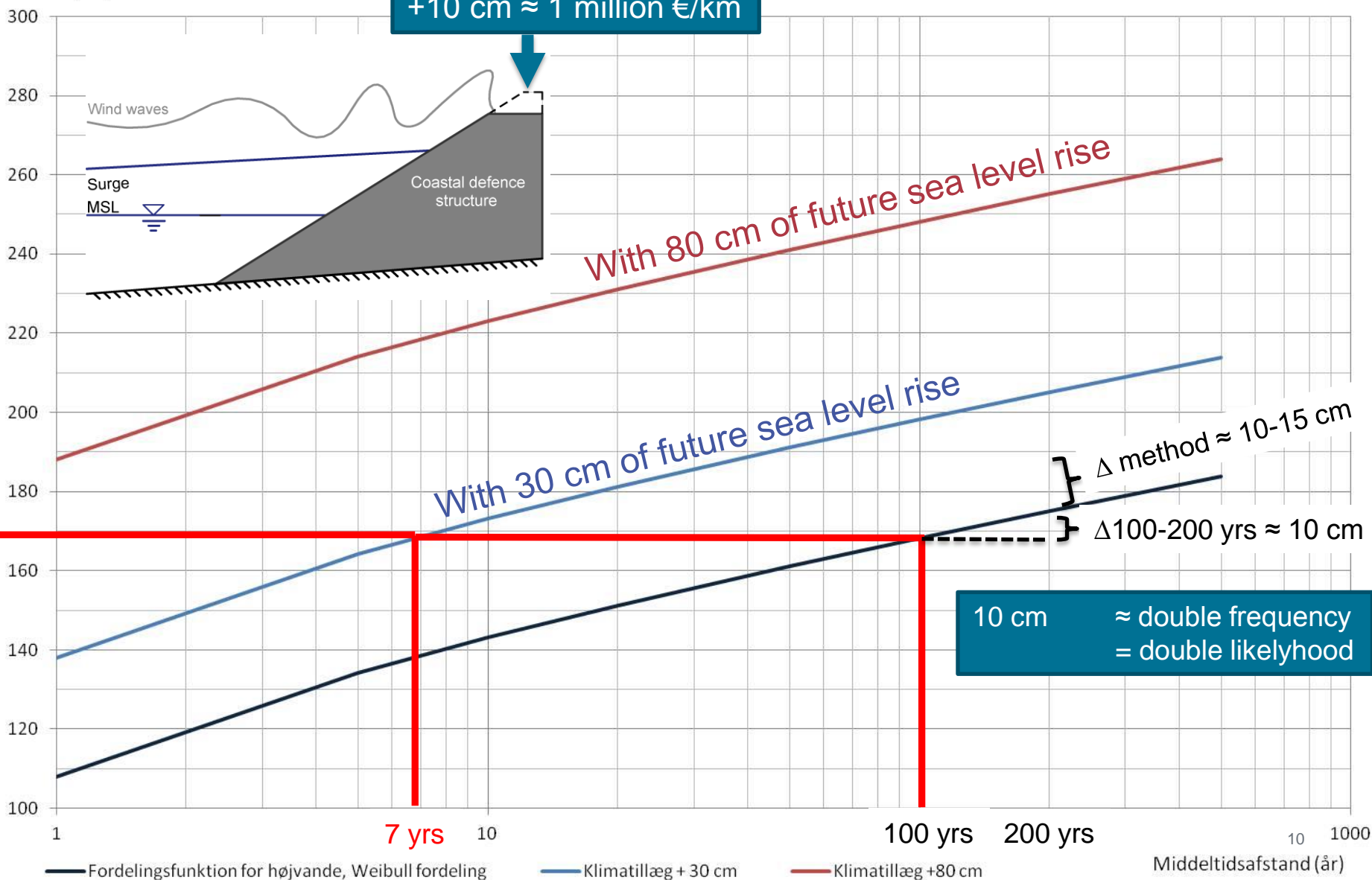
- 23 tide gauges
- 40–130 year series
- GEV-method
- 100 years RWL (lowest allowed building)
- + safety 50–100 cm
- Tides ignored



Nerheim et al. (2013)

Methodological differences: Are they important?

Vandstand (cm) Hornbæk Havn 2012

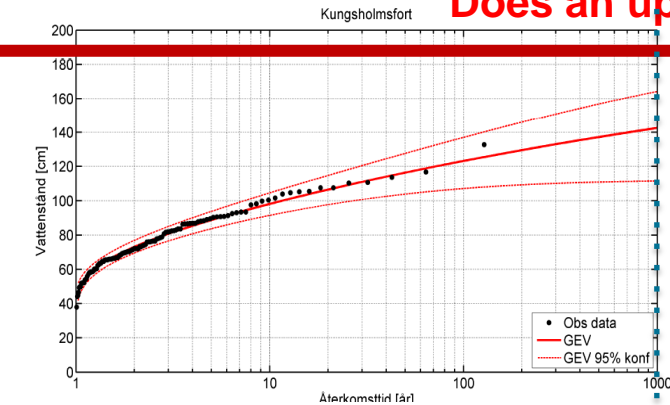




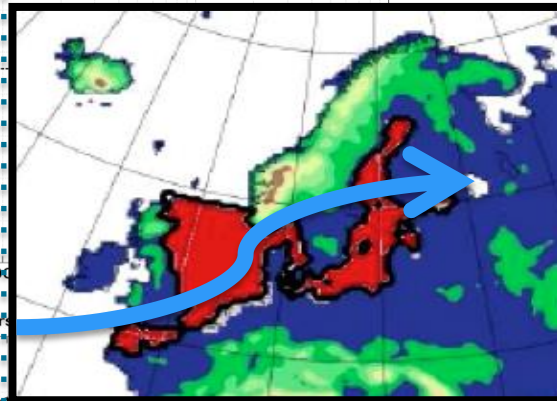
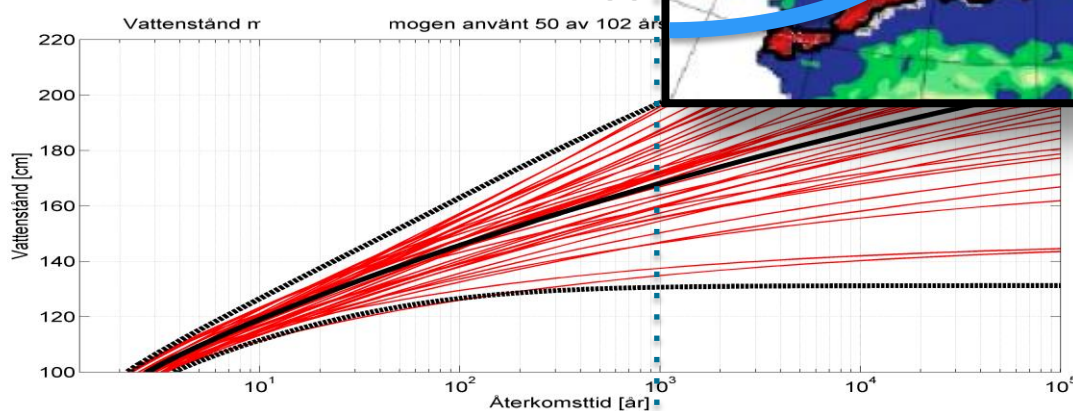
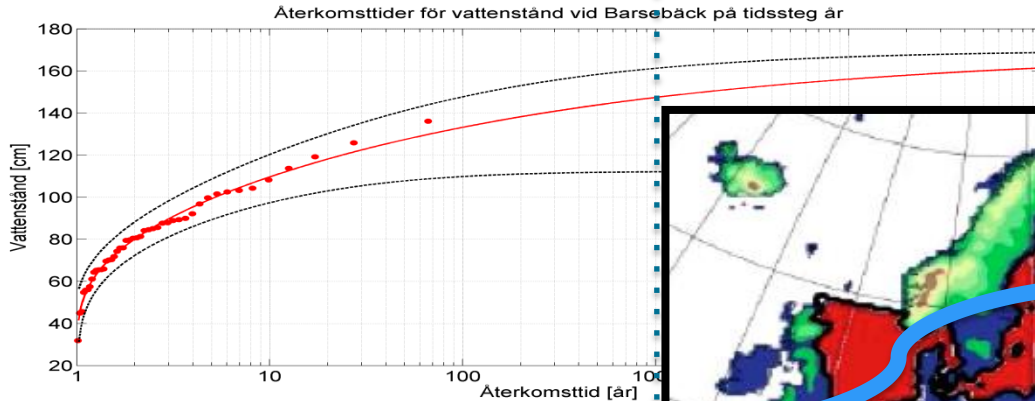
What about the more rare extremes?

Figur 7-2 Återkomststidskurva för GEV med tillhörande konfidensintervall, för Kungsholmsfort

Does an upper bound exist?



**1902 Christmas storm
in Lomma 206 cm**



**Results from (~50%)
subsamples diverge
severely**

- › Study in Sweden
- › A growing demand for upper bound, for design values
- › We do not know the worst storm in present climate
- › Statistical EVA is problematic for return periods longer than twice the time series
 - Most countries have at best 100 or some years time series
- › Modelling is deemed to be more suitable for design values
 - Models need to preserve energy at all frequencies
 - Forcing at borders needs to have realistic extremes
 - But hard to assess what a worst possible low pressure system is

Norway:

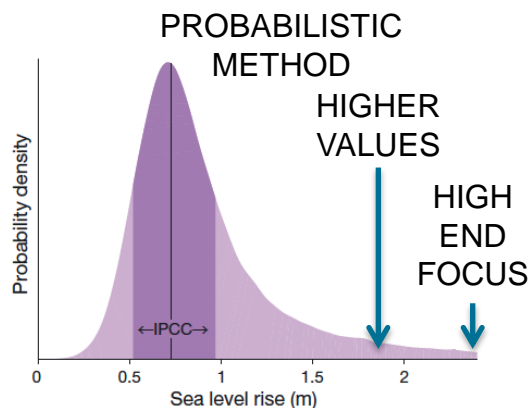
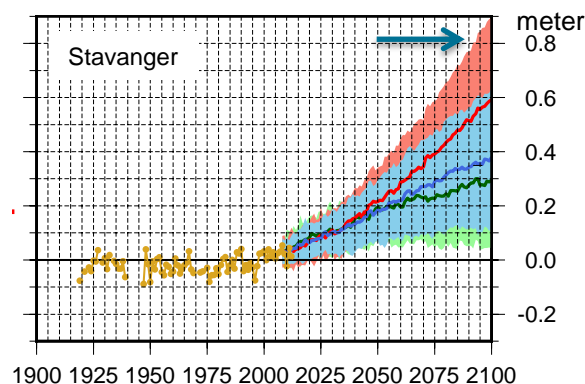
- IPCC AR5 based
- Land uplift replaced
- Recommendation RCP8.5 & 95% bound

Denmark:

- IPCC AR5 based
- Grinsted et al. (2015)

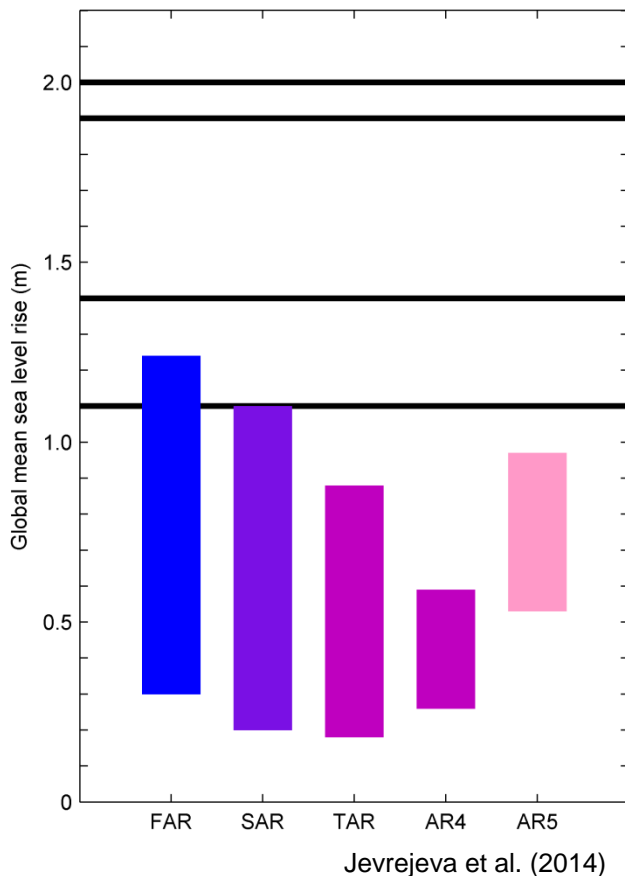
Germany:

- IPCC AR5 based
- Coastal protection climate change surcharge depends on federal state (e.g., 50 cm in Schleswig-Holstein)



In general no political decided number to use ...

Upper limits:



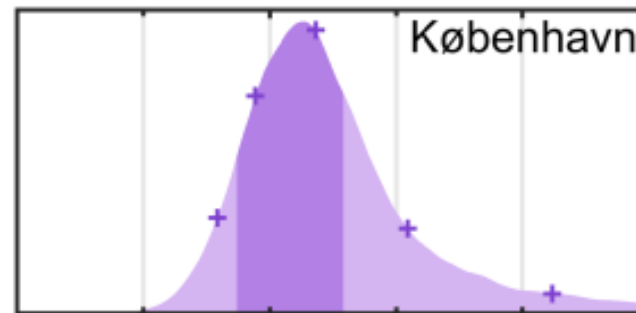
NOAA (2012)
UKCIP09

SCAR (2009)

Deltareport (2009)

IPCC

Likelyhood acceptance:



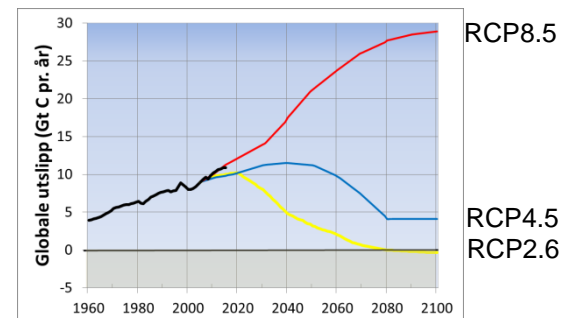
Grinsted et al. (2015)

83% = 1.05 m

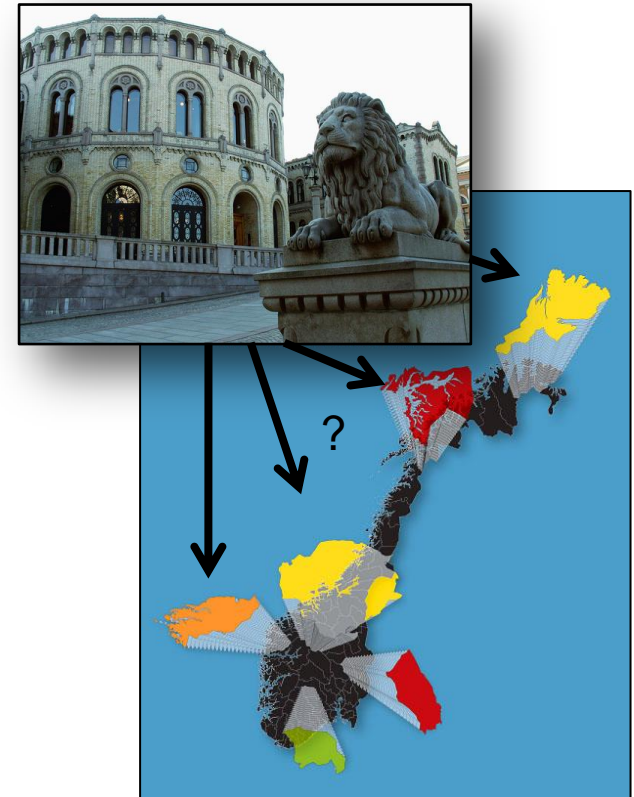
95% = 1.62 m

99% = 2.27 m

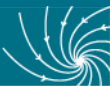
Emission scenario:
Not natural science
Social science



- › Choice of time span for adaptation planning (e.g. 2050, 2100, 2300?)
- › Mean sea level change or extreme height changes
- › Different responsibilities at different governance levels
- › Communication and implementation is a challenge
 - Rules, standards, encouragement
- › Two way (mis)communication
- › Realistic view on uncertainties and (im)possibilities



- › Regional collaboration is needed
 - Share views and experiences
 - Learn from each other and develop relevant methods
 - Gain a deeper understanding of current and future physical processes governing extreme events
 - Discuss potential challenges in the work ahead
 - Foster cross-disciplinary research
 - Improve collaboration between science and governance



Thank You!



ECRA Sea Level Change and Coastal Impacts Collaborative Programme

Sea level – Impacts – Risks – Adaptation

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